

High-Resolution TEM Studies of Nanostructures

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Case Western Reserve University

DMR-0114134

Silica-Based Nanostructures

Silica-based nanospheres, made by sublimation (J. Gole), have applications as sensors and catalysts. The new Tecnai F30 energy-filtering high-resolution transmission electron microscope at CWRU has provided insight into the atomic and electronic structure, and composition of these remarkable nanoparticles by high-resolution imaging combined with energy-filtering techniques (ESI), X-ray energy-dispersive spectroscopy, and electron energy-loss spectroscopy.

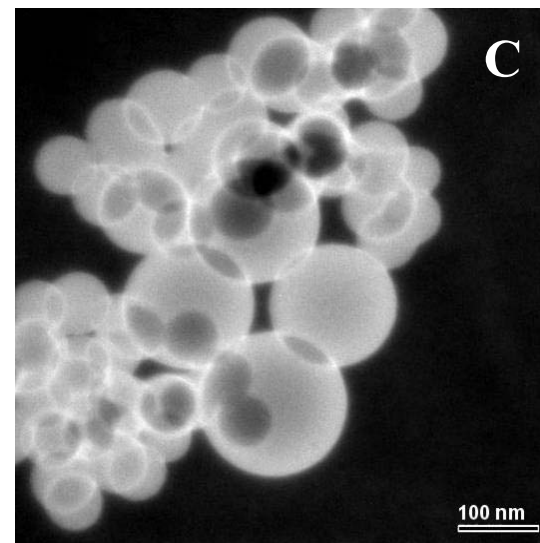
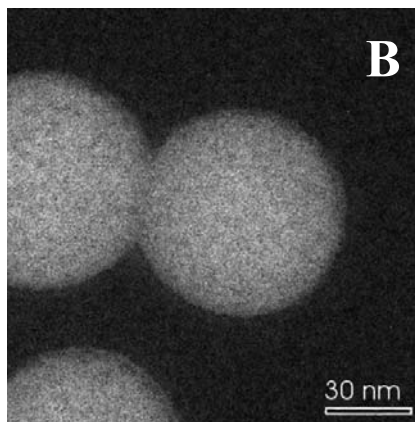
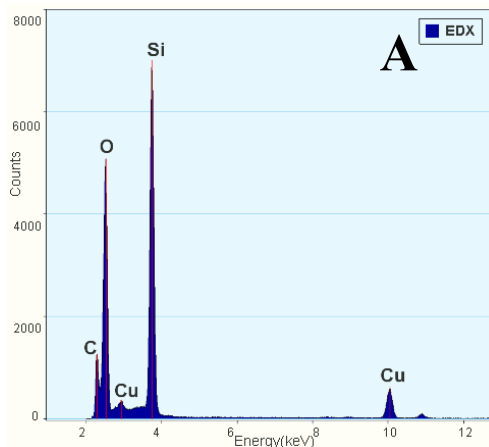


Fig. A: XEDS spectrum. Fig. B: Silicon elemental map obtained by electron-spectroscopic imaging (ESI). Fig. C: Plasmon loss image.

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Quantum-Well Quantum Dots

Core-shell nanocrystals of II–VI semiconductors, grown from aqueous solution by Prof. C. Burda, exhibit novel optical and electrical properties. With its resolution limit of 0.14nm, the Tecnai F30 enables the study of the morphology, crystal defects, and strain in these particles. The interpretation of the experimental results is verified by comparison with computer-simulated images of model structures.

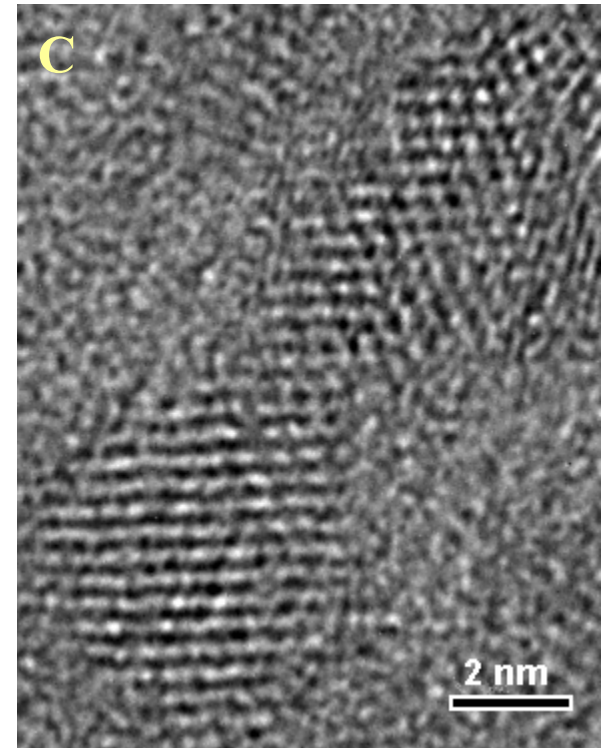
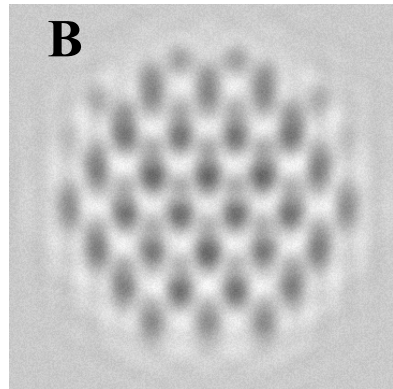
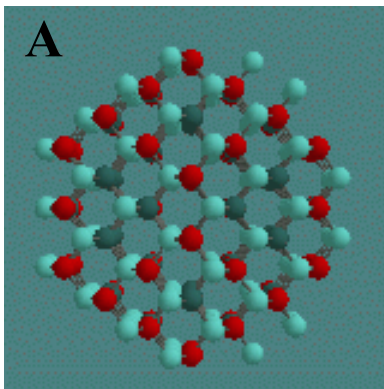


Fig. A: Model Structure of the CdS/HgS/CdS nanocrystal. Fig. B: Simulated TEM image. Fig. C: HRTEM image.

Education, Outreach and Mentoring

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A group of about ten graduate students and postdoctoral researchers has been trained to operate the Tecnai F30 and to train new users. Regular meetings and a global newsgroup (cwru.csam.tecnaif30) were established to exchange experience with the new instrument and discuss the scientific background of advanced techniques. The new microscope plays a central role in our graduate course EMSE-512 on Advanced Methods of TEM. Starting this fall, the new instrument will also be used by undergraduate students in their senior projects. In addition, we will visit middle school classrooms to introduce the students to materials microstructures via TEM images, and offer research opportunities for under-represented minorities in HBCs and in a small female-only college in suburban Cleveland.

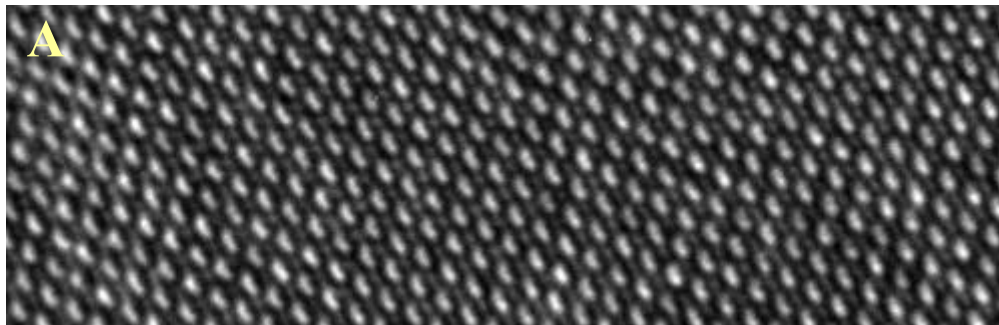


Fig. A: Graduate student operating the Tecnai F30. Fig. B: Lattice image of Si, obtained by a student in our graduate course EMSE-512 (<http://vulcan2.cwru.edu/classes/emse512>)